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Legal Limitations on Genetic Research and the Commercialization of Its Results

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The United States continues to pursue the commercial application of biotechnology with passion and aggression.[1] The pharmaceutical and biotechnology sectors reported a $49.3 billion investment in research and development (R&D) in human health products in 2004 and, among the multiple conduits for federal government investment in biomedical research, the operating budget of the National Institutes of Health (NIH) alone was $28 billion that year.[2] With a map of the human genome in hand,[3] making medical sense out of that map is an ongoing endeavor undertaken by the U.S. government, academia, and the private sector, often in collaboration.[4]

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1. *See generally* PHRMA, PHARMACEUTICAL INDUSTRY PROFILE 2005 (2005) ["PROFILE"], *available at* www.phrma.org.

2. *See id.* at pp. 2-6; National Institutes of Health, *Summary of the FY2006 President's Budget* (2005), http://www.nih.gov/about/director/budgetrequest/index.htm. Jonathan Weisman, *2006 Cuts in Domestic Spending on Table*, WASH. POST, May 27, 2004, at A01, *available at* 2004 WL 74490860; *Drug Development; Medicine Price Hike Highlights Controversy of Government Funding Drug Research*, MED. LETTER ON CDC & FDA 27 (June 20, 2004), 2004 WL 55170701 (no author identified). 2005 industry data is not available at this time.

3. HGP was driven to completion years ahead of schedule through competition between industry and government-led teams that ultimately joined forces to declare a joint victory. *See generally* 291 SCIENCE 1145 (Feb. 16, 2001) (issue entitled "The Human Genome"); 409 NATURE 745 (Feb. 15, 2001) (issue *Information about the Human Genome Project* dedicated to the release of a draft map of the human genome). Information about HGP may be obtained from the National Human Genome Research Institute (NHGRI) at www.nhgri.nih.gov.

4. PROFILE, *supra* note 1, at 8-14. *See generally* U.S. Senate, Joint Economic Committee, *The Benefits of Medical Research and the Role of the NIH* (May 2000) (examining the role of federal funding for medical research and derivative benefits); GENERAL ACCOUNTING OFFICE, REPORT TO CONGRESSIONAL COMMITTEES: TECHNOLOGY TRANSFER, ADMINISTRATION OF THE BAYH-DOLE ACT BY RESEARCH UNIVERSITIES, GAO/RCED-98-126 (May 1998), *available at* www.access.gpo.gov; DEP'T HEALTH & HUMAN SERVS., NAT'L INST. OF HEALTH, NIH RESPONSE TO THE CONFERENCE REPORT REQUEST FOR A PLAN TO ENSURE TAXPAYERS' INTERESTS ARE PROTECTED (July 2001), *available at* http://www.nih.gov/news/070101wyden.htm; National Institutes of Health, Office of

The maturation of biotechnology as applied science is transforming industry and at least beginning to have a meaningful impact on the delivery of health care.[5] As recognized by the pharmaceutical industry, "the convergence of traditional pharmaceutical chemistry and biotechnology has led to the pharmaceutical and biotechnology industries, once thought of as being distinct and independent, [becoming] more similar than dissimilar."[6] After decades of dependence upon pharmaceuticals to treat human health needs, the emerging generation of medicines are *bio*pharmaceuticals.[7] The integration of biotech application and the delivery of health care is adding a new dimension of complexity to familiar pressing issues such as health care finance, and also introducing significant changes to the fundamentals of health care delivery and the human medicinal product markets.[8] For example, developing pharmaceuticals around alleles (genetic variations) is resulting in much more precision, and large disease groupings such as "breast cancer" are being broken down into BRCA1/BRCA2-associated breast cancer, Her-2-neu-associated breast cancer, and other genetic-based sub-classifications.[9] Genetic profiling capabilities are expanding immensely, both as a by-product of biopharmaceutical R&D centered on genomics and its cousin disciplines[10] and through efforts such as the SNPs Consortium—a collaboration to identify genetic subtleties that have medical meaning, such as an individual patient's reaction to commercial pharmaceuticals.[11]

Technology Transfer, *NIH Technologies in the Development of Drugs, Diagnostics, and Research Tools* (2003), http://ott.od.nih.gov/newpages/techdev.pdf.

5. For identification of biotech medicines and vaccines brought to market, see *Biotechnology & Health Care, available at* www.bio.org (official Internet site of the world's largest biotechnology trade organization). Biotechnology also has been used to develop medical devices and other human health products, including tissue products,]\that impact human health directly. Information about these products is available at the official web site of the Food and Drug Administration, www.fda.gov. More than 320 biotech drugs and vaccines are now in clinical trials. *See generally* PHARMACEUTICAL RESEARCH AND MANUFACTURERS OF AMERICA, MEDICINES IN DEVELOPMENT: BIOTECHNOLOGY (Oct. 2004).

6. PROFILE, *supra* note 1, at vi.

7. *Id.* For identification of biotech medicinal products, *visit* www.bio.org. (the official web site of the Biotechnology Industry Organization).

8. *See generally* A.E. Guttmacher, F.S. Collins, *Welcome to the Genomic Era*, NEW ENGLAND J. MED. 349 (2004): 996-98, *available at* www.nejm.org. *See also* L. Noah, *The Coming Pharmacogenomics Revolution: Tailoring Drugs to Fit Patients' Genetic Profiles*, 43 JURIMETRICS: THE JOURNAL OF LAW, SCIENCE, AND TECHNOLOGY 1, 4-11 (2002); Michael J. Malinowski, *Law, Policy, and Market Implications of Genetic Profiling in Drug Development*, 2 H. J. OF HEALTH LAW & POL'Y 31-63, 31-43 (2003).

9. The Baylor College of Medicine has established online-searching capabilities for breast cancer genes. *See* Baylor College of Medicine, Breast Cancer Gene Database, at http://condor.bcm.tmc.edu/ermb/bcgd/bcgd.html.

10. For example, genetic profiling is being utilized to tailor human clinical trials—a field known as pharmacogenomics. *See generally supra* note 8.

11. Complementary fields are pharmacogenomics (research centered on the expression of alleles shared by groups) and pharmacogenetics (tailoring of health care

This Report focuses on several issues presently at the epicenter of biotechnology-related controversy in science, medicine, and law-policy within the U.S. The Report is organized along the R&D continuum spanning from basic research to medicinal and commercial applications.[12] Parts I through III address priority issues in basic research at this time: gene patents, human cloning and stem cell research, and population genetics, respectively. Part III includes discussion of the International Haplotype Mapping Project and Consortium (HapMap Project) presently underway through the National Institutes of Health (NIH), National Human Genome Research Institute (NHGRI).[13] Part IV addresses the impact of applied biotechnology on assisted reproduction, a burgeoning commercial sector in the U.S.[14] Part V explores the extent to which the challenges before and controversies being experienced by the "gatekeeper" to the U.S. biopharmaceutical market, the Food and Drug Administration (FDA), may impact biotechnology R&D and the biopharmaceutical markets. Part VI addresses the nexus between the health care finance dilemma in the U.S. and commercial biotechnology. The Report concludes that the U.S., the primary incendiary of the "genomics revolution," has made a multifaceted—governmental, commercial, and health care—commitment to biotechnology, and that loyalty remains strong as the U.S. grapples with associated law-policy complexities, both in basic research and health care applications.

I. GENE PATENTS

Now that the map of the human genome is complete, much of the genetic code has already been claimed for private ownership. Companies and universities have obtained patents on more than 4,000 human genes, almost 20 percent of the roughly 24,000 human genes.[15] Whether human genes should be patentable is hotly contested. Some oppose the patenting of human genes on moral grounds, arguing that human beings should not be the subject of

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and biopharmaceuticals to individual genetic profiles). *See generally* Malinowski, *Genetic Profiling*, *supra* note 8; Noah, *Pharmacogenomics*, *supra* note 8.

12. This organization reflects that utilized by one of the authors in his treatise on biotechnology R&D, BIOTECHNOLOGY: LAW BUSINESS, AND REGULATION (Aspen 1999 & supps., 2000-2004).

13. Official sites with information about the HapMap Project are www.hapmap.org and www.genome.gov.

14. *See* Michael J. Malinowski, *Choosing the Genetic Makeup of Children: Our Eugenics Past—Present, and Future?*, 36 CONN. L. REV. 125, 179-97 (2003). *Cf.* PRESIDENT'S COUNCIL ON BIOETHICS, REPRODUCTION AND RESPONSIBILITY: THE REGULATION OF NEW BIOTECHNOLOGIES 54-63 (2004), *available at* http://www.bioethics.gov/reports/reproductionandresponsibility/_pcbe_final_reproduction_and_responsibility.pdf.

15. Stefan Lovgren, *One-Fifth of Human Genes Have Been Patented, Study Reveals*, National Geographic News, October 13, 2005.

property rights.[16] Others object that DNA sequences should not be patentable because they are discoveries of nature that are the common heritage of all, rather than man-made inventions.[17]

Nevertheless, current U.S. policy as set by Congress, the Patent and Trademark Office (PTO), and the federal courts permits patents on human genes. As explained by a former director of the PTO: "From a patent law standpoint, genes are treated just like any other chemical found in nature."[18] The U.S. Constitution grants Congress the exclusive power "[t]o promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries."[19] Congress has implemented this power by enacting a group of statutes known as the Patent Act,[20] which authorize patents to be issued if the subject matter of the invention is patentable, i.e., a "process, machine, manufacture, or composition of matter,"[21] and if the invention is "useful,"[22] "novel,"[23] "non-obvious,"[24] and "adequately enabled and described."[25]

Patents can be issued for "anything under the sun that is made by man," but not for "laws of nature, physical phenomena, and abstract ideas."[26] Thus, in *Diamond v. Chakrabarty*, the Supreme Court allowed a genetically-engineered living microorganism to be patented because it was the product of human ingenuity.[27] While newly-discovered plants, minerals, and other natural phenomena cannot be patented because they exist without human intervention,[28]

16. *See, e.g.*, Gail E. Bundy, Letter to Commissioner of Patents and Trademarks, Comment 2, Public Comments on the United States Patent and Trademark Office, *Revised Interim Utility Examination Guidelines*, 64 FR 71440, Dec. 21, 1999, *corrected* 65 FR 3425, Jan. 21, 2000, *available at* http://www.uspto.gov/web/offices/com/sol/comments/utilguide/index.html (arguing that the PTO lacks authority to grant patents on human genes because they are part of life, and all life is sacred).

17. *See, e.g.*, Debra Harry, Letter to Commissioner of Patents and Trademarks, Indigenous Peoples Council on Biocolonialism, Comment 39, Public Comments on the United States Patent and Trademark Office, *Revised Interim Utility Examination Guidelines*, 64 FR 71440, Dec. 21, 1999, *corrected* 65 FR 3425, Jan. 21, 2000, *available at* http://www.uspto.gov/web/offices/com/sol/comments/utilguide/index.html (contending that human genes are not patentable because they are products of nature, not inventions).

18. Andrew Pollack, *Patenting a Human Gene As if It Were an Invention*, N.Y. TIMES, June 28, 2000, at C1.

19. U.S. Const. Art. I., Sec. 8, Cl. 8.

20. 35 U.S.C. §§1 *et seq*.

21. 35 U.S.C. §101.

22. 35 U.S.C. §101.

23. 35 U.S.C. §102.

24. 35 U.S.C. §103.

25. 35 U.S.C. § 112.

26. *Diamond v. Chakrabarty*, 447 U.S. 303, 309 (1980).

27. *See id.* at 309-310.

28. *See Funk Brothers Seed Co. v. Kalo Inoculant Co.*, 333 U.S. 127 (1948) (finding a new combination of bacteria to be "no more than the discovery of some of the handiwork of nature and hence . . . not patentable").

isolated and purified versions of naturally occurring substances are patentable.[29] Gene patents lie at the intersection of these two lines of precedent because they involve isolated and purified DNA sequences from living organisms. In upholding a gene patent, one federal court reasoned: "The invention claimed in the patent is not . . . the DNA sequence encoding human EPO since that is a nonpatentable natural phenomenon 'free to all men and reserved exclusively to none. . . .' Rather, the invention as claimed . . . is the 'purified and isolated' DNA sequence encoding erythropoietin."[30]

A gene patent grants what is essentially a monopoly over the gene for 20 years, giving its owner the power to prevent others from conducting research, performing tests, or developing therapies for that gene without obtaining a license and paying royalties. As a result, gene patents may actually hinder innovation[31] and impede the delivery of health care services.[32] For these reasons, gene patents have been the subject of much criticism, although a study published in *Science* in March 2005 suggests that the problem is not the theory but the practice of the PTO in approving too many flawed gene patents. After examining 74 human gene patents, the study concludes that almost three-fourths of these patents contain at least one "problematic" claim, that is, a claim that fails to satisfy the legal requirements for a patent.[33]

Moreover, unlike many other countries, the U.S. has no explicit research exception to its patent laws that would allow basic research using patented genes to proceed without obtaining permission from the patent holder.[34] There is a statutory exemption for use of a patented invention that is "reasonably related to the development and submission of information under a Federal law which regulates the

29. *See Parke-Davis & Co. v. H.K. Mulford Co.*, 189 F.95 (S.D.N.Y. 1911) (upholding a patent on an isolated and purified version of adrenalin that had been extracted from the glands of animals).

30. *Amgen Inc. v. Chugai Pharmaceutical Co., Ltd.*, 1989 U.S. Dist. LEXIS 16110, *88-89 (D. Mass., December 11, 1989), affirmed in relevant part, 927 F.2d 1200 (Fed. Cir. 1991), *cert. denied*, 502 U.S. 856 (1991).

31. *See* Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, SCIENCE, May 1, 1998, at 698 (explaining how patents may deter innovation in biomedical research: "A proliferation of intellectual property rights upstream may be stifling life-saving innovations further downstream in the course of research and product development.").

32. *See* Lori B. Andrews, The *Gene Patent Dilemma: Balancing Commercial Incentives with Health Needs*, 2002 HOUS. J. HEALTH L. & POL'Y 65, 89 (2002).

33. Jordan Paradise, Lori Andrews, Timothy Holbrook, *Patents on Human Genes: An Analysis of Scope and Claims*, 307 SCIENCE 1566 (Mar. 11, 2005). *See also Bad Gene Patents*, THE ECONOMIST, Mar. 12, 2005.

34. *See* Lori Andrews, *supra* note 32, at 86. *See also* Rebecca S. Eisenberg, *Patents and the Progress of Science: Exclusive Rights and Experimental Use*, 56 U. CHI. L. REV. 1017, 1018-1019 n. 6 (1989) (describing European research exception to patent law); Janice M. Mueller, *No "Dilettante Affair": Rethinking the Experimental Use Exception to Patent Infringement for Biomedical Research Tools*, 76 WASH. L. REV. 1, 39 (2001) (describing Japan's experimental use exception).

manufacture, use, or sale of drugs."[35] However, the Supreme Court recently interpreted this exemption to exclude "[b]asic scientific research . . . performed without the intent to develop a particular drug."[36] And the common law research exception has been construed extremely narrowly by the Federal Circuit to apply only to research that is "solely for amusement, to satisfy idle curiosity, or for strictly philosophical inquiry."[37] Even research with no commercial applications performed in a university setting does not qualify for this exception because it furthers the university's "legitimate business objectives" by increasing the status of the institution and attracting research grants, students, and faculty.[38]

II. HUMAN CLONING AND STEM CELL RESEARCH

In 1996, Ian Wilmut succeeded in cloning the famous lamb Dolly,[39] spurring scientists to use the same technique to clone many other animals, including cows,[40] mice,[41] horses,[42] and dogs.[43] There have even been attempts to clone human beings, with ACT (Advanced Cell Technology), a small company in Boston, reporting that it had cloned human embryos in October 2001,[44] and rumors of the birth of a cloned human child floating around in December 2002.[45] More recently, scientists have touted the promise of embryonic stem cells for medicine and South Korean researchers claimed that they actually managed to clone human embryos for the purpose of harvesting stem cells.[46] Also, a team of Harvard scientists announced a rev-

35. 35 U.S.C. §271(e)(1).

36. *See Merck v. Integra Lifesciences*, 125 S. Ct. 2372, 2382-2383 (2005) (holding that the statutory exemption applies only if there is a "reasonable basis" for believing that use of the patented compound in research, if successful, would be appropriate to include in a submission to the FDA, even if the patented compound is used (1) in experiments on drugs that are not ultimately submitted to the FDA or (2) in experiments that are not ultimately submitted to the FDA).

37. *Madey v. Duke University*, 307 F.3d 1351, 1362 (Fed. Cir. 2002).

38. *Id.* at 1362.

39. Michael Specter, *A New Creation: The Path to Cloning*, N.Y. TIMES, Mar. 3, 1997, at A1.

40. Gina Kolata, *Holstein Calves Cloned From Cells, Paper Says*, N.Y. TIMES, May 23, 1998, at A11.

41. Gina Kolata, *In Big Advance, Cloning Creates Dozens of Mice*, N.Y. TIMES, July 23, 1998, at A1.

42. Gareth Cook, *Scientists in Italy Clone Horse*, BOSTON GLOBE, Aug. 7, 2003, at A1.

43. Rowan Hooper, *First Canine Clone Is a Chip Off the Old Block*, NEW SCIENTIST, Aug. 6, 2005, at 15.

44. Gina Kolata, *A Breakthrough On Cloning?*, N.Y. TIMES, Nov. 27, 2001, at A1. For information about Advanced Cell and its research, visit the company Internet site at http://www.advancecell.com.

45. Linda Greenhouse, *FDA Exploring Human Cloning Claim*, N.Y. TIMES, Dec. 30, 2002, at A10.

46. James Brooke, *Without Apology, Leaping Ahead in Cloning*, N.Y. TIMES, May 31, 2005, at F1. Dr. Hwang Woo Suk, the principal South Korean researcher, received world acclaim as the first person to successfully clone a human embryo and extract

olutionary new cell fusion technique which may generate stem cells with less controversy.[47]

Much of the debate surrounding genetic research in the U.S. has focused on the twin issues of human cloning and the production of stem cells from human embryos,[48] perhaps because of a perceived link to the controversial topic of abortion. Of the two issues, human embryonic stem cell research (HESCR) has received the most publicity. On August 9, 2001, President George W. Bush addressed the nation on this topic, declaring a ban on federal funding for any research involving human embryonic stem cells that were created after that date.[49] This action severely limited the scope of federally-funded research on human embryonic stem cells to the small number of cell lines already in existence at the time of the President's announcement. Moreover, HESCR has itself become a potent political issue, as is evident in the fact that Ronald Reagan Jr., son of the venerated Republican President, crossed party lines to make a dramatic appearance at the Democratic Convention, emphasizing the importance of allowing such research.[50] Indeed, an unofficial commission of 80 Nobel prizewinners even wrote a letter to President George W. Bush expressing their strong support for federal funding for stem research, citing the promise of "novel therapies for a range of serious and currently intractable issues."[51]

Apart from the ban on federally-funded HESCR, there are no federal laws that specifically limit human cloning or stem cell research as of December 2005. To the contrary, some states are actively pro-

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stem cells from it. In November 2005, however, Dr. Hwang acknowledged that he lied over the sources of human eggs used in his work and stepped down as Director of a new research center. *See* James Brooke, *Korean Leaves Cloning Center in Ethics Furor,* N.Y. TIMES, Nov. 25, 2005, at A1, A8. Some eggs were donated by his junior researchers, while others were drawn from about 20 women who were paid for their eggs. *See id.* And in December 2005, Dr. Hwang admitted that he had fabricated some of his research, raising doubts regarding the feasibility of creating stem cells from cloned human embryos. See Nicholas Wade, *Korean Scientist Said to Admit Fabrication in a Cloning Study,* N.Y. TIMES, Dec.16, 2005, at A1, A6.

47. Gareth Cook & Carey Goldberg, *Harvard Scientists Advance Cell Work: Technique Doesn't Destroy Embryos*, Boston Globe, August 22, 2005. After fusing an adult human skin cell with an existing embryonic stem cell, the Harvard scientists found that the resulting hybrid looked and acted like an embryonic stem cell. This technique may eventually make it possible to obtain genetically-matched embryonic stem cells for use in medical therapy using existing cell lines, without the need to create and destroy cloned human embryos. *See id.*

48. Rick Klein, *GOP Leader Looks For a Stem Cell Avenue*, BOSTON GLOBE, Jul. 13, 2005, at A3.

49. Press Release, The White House, Office of the Press Secretary, Remarks by the President on Stem Cell Research (Aug. 9, 2001), *available at* http://www.whitehouse.gov/news/releases/2001/08/20010809-2.html); *see also*, Aaron Zitner, *Bush OKs Limited Stem Cell Funding*, L.A. TIMES, Aug. 10, 2001, at A1.

50. Robin Toner, *On 2nd Night, Unity Is Theme For Democrats*, N.Y. TIMES, Jul. 28, 2004, at A1.

51. Gretchen Vogel, *Nobel Laureates Lobby for Stem Cells*, SCIENCE, Mar. 2, 2001, Vol. 291, at 1683.

moting such research. For example, California voters recently approved Proposition 71, which devotes the unprecedented sum of $3 billion of public money to fund stem cell research.[52] Other states seem to be following suit, seeking to encourage stem cell research, albeit without allocating such large amounts of public money.[53] However, many states have enacted laws that ban human reproductive cloning,[54] while some states also prohibit non-reproductive cloning, effectively preventing certain forms of stem cell research.[55] Moreover, both human cloning and embryonic stem cell research are subject to a patchwork of general federal regulations, such as those governing research upon human subjects, and any clinical applications of such research would obviously require FDA approval.[56]

The dearth of federal regulation has prompted scientists to propose a system of self-regulation. Thus the National Academy of Sciences, a self-selected group of scientists that advises the government, issued a comprehensive set of guidelines for HESCR in April 2005, in the hope that these limits would be voluntarily adopted by all institutions engaged in such research.[57] The guidelines call for the establishment of a national commission, as well as local committees (called Embryonic Stem Cell Research Oversight or ESCRO committees) to oversee such research. They require the informed consent of all persons who donate eggs, sperm, embryos, or other genetic material and prohibit the payment of donors.[58] They recommend that certain forms of embryonic stem cell research be prohibited, including re-

52. California Stem Cell Research and Cures Act (Proposition 71), adopted by voters at the 2004 general election, effective Nov. 3, 2004, as codified in Ch. 3 of the California Health & Safety Code. Proposition 71 has been challenged on state constitutional law grounds by several organizations, including the California Family Bioethics Council, the People's Advocate, and the National Tax Limitation Foundation. Alameda County Superior Court Judge Bonnie Lewman Sabraw declined to dismiss the lawsuits, which are scheduled to go to trial on Feb. 27, 2006. *See* Megan Garvey, *Stem Cell Lawsuits Survive Challenge*, L.A. TIMES, Nov. 30, 2005; *Judge Has Crucial Role in Future of Stem Cell Research*, SACRAMENTO BEE, Dec. 8, 2005.

53. Tina Kelly, *In Race Toward First Stem Cell Research Institute, New Jersey Stalls*, N.Y. TIMES, July 31, 2005, at 25; *see also* Betsy Morris, *Fighting for Their Lives*, FORTUNE, Aug. 22, 2005, at 48. New Jersey and eight other states are in various stages of the legislative and initiative process.

54. States that prohibit only reproductive cloning include California, Connecticut, Massachusetts, New Jersey, and Rhode Island. *See* The National Academies, *Guidelines for Human Embryonic Stem Cell Research*, National Academy Press, Apr. 26, 2005, at 75. (*see http://books.nap.edu/catalog/11278.html?onpi_newsdoc0262005* [hereinafter "NAS Report"].

55. States that proscribe both reproductive and research cloning include Arkansas, Indiana, Iowa, Michigan, North Dakota, and South Dakota. *See* NAS Report, *supra* note 54, at 75.

56. *See* NAS Report, *supra* note 54, at 3.

57. *See generally id. See also* Nicholas Wade, *Scientists Draft Rules on Ethics For Stem Cells*, N.Y. TIMES, Apr. 27, 2005, at A11; The National Academies, *Guidelines for Human Embryonic Stem Cell Research*, National Academy Press, Apr. 26, 2005 (*see* http://www4.nationalacademies.org/news.nsf/isbn/0309096537?OpenDocument).

58. *See* NAS Report, *supra* note 54, at 101.

search upon a human embryo for longer than 14 days, beyond development of the primitive streak, and research in which human embryonic stem cells are introduced into human blastocysts or non-human primate blastocysts.[59] The guidelines also provide that animals into which human embryonic stem cells have been introduced should not be allowed to breed.[60]

When stem cell research is disentangled from the issue of human cloning, it appears to have widespread support.[61] Thus the House of Representatives, in a bipartisan effort, passed House Resolution 810, the Stem Cell Research Enhancement Act of 2005, on May 24, 2005.[62] House Resolution 810 overturns President George W. Bush's executive order barring the use of federal funds for HESCR and instead *requires* the Secretary of Health and Human Services to conduct and support such research, regardless of the date on which the stem cells were derived from a human embryo, provided that the embryos: (1) were donated from in vitro fertilization clinics; (2) were created for the purpose of fertility treatment; (3) were in excess of the needs of the individuals seeking such treatment and would otherwise be discarded; and (4) were donated by such individuals with written informed consent and without any financial or other inducements.[63] The Act would also require the Secretary to submit annual reports on activities and research conducted under its auspices.[64] However, until this Act passes the Senate with the necessary margin of support to sustain a Presidential veto, it will not become law.

Unfortunately, HESCR has become closely connected to the even more controversial issue of human cloning.[65] Many supporters of HESCR have emphasized the importance of therapeutic cloning, especially after the widely-reported accomplishments of Dr. Hwang Woo Suk and his South Korean research team, though these alleged accomplishments are now suspect.[66] Yet human cloning for therapeutic purposes and human cloning for reproduction have proven innately entangled because advances in somatic cell nuclear transfer ("SCNT") and other techniques derived from therapeutic cloning re-

59. *See id.* at 99.

60. *See id.*

61. *Poll Finds Majority of Americans Support Embryonic Stem Cell Research*, PHYS. L. WEEKLY, Sep. 7, 2005. The poll, conducted by KRC Research on behalf of the Coalition for Pulmonary Fibrosis, found that 73% of Americans believe stem cell research could one day lead to new disease treatments and cures, and that 70% support increasing federal funding for the research. *Id.*

62. Stem Cell Research Enhancement Act of 2005, H.R. 810, 109th Cong. (as passed by House May 24, 2005).

63. H.R. 810 at § 498D(b).

64. H.R. 810 at § 498D(d).

65. *See generally* Michael J. Malinowski, *The Impact of Current Policy and Regulations on Future Stem Cell Human Health Applications*, 39 NEW. ENG. L. REV. 647 (2005) (live and published symposium).

66. *See supra* note 46 and accompanying text.

search have tremendous spillover potential into human cloning for reproduction.[67] The goal of many involved in embryonic stem cell research is to build upon the research allegedly performed by Dr. Hwang Woo Suk and his team—to use SCNT to clone and create stem cells and tissue derivatives that are compatible with human donors to be used in their individualized treatment and thereby avoid issues of rejection.[68]

As a result, the legality of stem cell research rests in large part upon the scope of the definition of "human cloning" used in legislation and the existence of any exceptions for research or therapeutic cloning.[69] If a law banning human cloning draws the line at implantation, then only reproductive cloning would be prohibited. But if the law defines cloning as occurring at nuclear transplantation, then research and therapeutic cloning—including the production of stem cells from cloned human embryos—would also be prohibited. Thus legal limitations upon human cloning may also circumscribe HESCR that involves SCNT.

In the U.S., several bills in Congress purport to regulate human cloning, and each bill adopts a distinct definition. House Resolution 534, the Weldon Bill, was passed by the House of Representatives on February 27, 2003, but never approved by the Senate.[70] It defines human cloning as occurring at the point of nuclear transplantation, thereby proscribing research and therapeutic cloning, including the production of stem cells from cloned human embryos.[71] Senate Bill

67. As explained in detail in the NAS Report, *supra* note 54, at 34-35, human cloning involves several stages: removal of the nucleus from a human egg, transfer of the nucleus from a cell of the person to be cloned into the enucleated egg, stimulation with an electrical current in order to start cell division; this is the process known as SCNT which was used to create Dolly and other animal species clones. *See supra* notes 39-43 and accompanying text. Human cloning for reproduction involves implantation of the product of SCNT into a uterus, followed by gestation and ultimately birth of a cloned animal or possibly a person. *See* NAS Report, *supra* note 54, at 32-33. Therapeutic cloning uses SCNT to create donor-compatible non-differentiated cells, which then could be differentiated to create donor stem cells and tissue applications for treatment. *See id.* at 33.

68. *See generally supra* note 67.

69. *See generally* Bert Vogelstein et al., *Please Don't Call it Cloning!*, 295 Science 1237 (2002); Margaret R. McLean, *What's In a Name? "Nuclear Transplantation" and the Ethics of Stem Cell Research*, 53 Hast. L.J. 1017 (2001-2002); Human Cloning and Human Dignity: An Ethical Inquiry, Report of the President's Council on Bioethics, July 2002, at 35-43 (see http://www.bioethics.gov/reports/cloningreport/pcbe_cloning_report.pdf).

70. Human Cloning Prohibition Act of 2003, H.R. 534, 108th Cong. (as passed by House, Feb. 27, 2003).

71. Specifically, the Weldon Bill defines "human cloning" as "human asexual reproduction, accomplished by introducing nuclear material from one or more human somatic cells into a fertilized or unfertilized oocyte whose nuclear material has been removed or inactivated so as to produce a living organism (at any stage of development) that is genetically virtually identical to an existing or previously existing human organism." H.R. 534, at §301(1). The Weldon Bill makes it unlawful to perform, attempt to perform, or participate in "human cloning," and it expressly prohibits

245,[72] another bill pending in the Senate that was proposed by Senator Brownback, is almost identical to the Weldon Bill and adopts the same definition of human cloning.[73]

A third bill, Senate Bill 303,[74] proposed by Senators Hatch, Feinstein, Specter, Kennedy, Harkin, and Miller, defines human cloning in such a way as to permit stem cell research.[75] Specifically, the Hatch Bill defines "human cloning" as "implanting or attempting to implant the product of nuclear transplantation into a uterus or the functional equivalent of a uterus"[76] and it labels the product of nuclear transplantation an "unfertilized blastocyst."[77] The Hatch Bill does not proscribe SCNT when performed for research or therapeutic purposes, but instead sets forth standards regulating such research, including: voluntary donation of oocytes with informed consent, prohibition upon the purchase or sale of human oocytes or unfertilized blastocysts, Institutional Review Board (IRB) approval of all such research, prohibition of research upon unfertilized blastocysts after 14 days, and segregation of nuclear transplantation research from assisted reproductive technology treatments.[78]

Many commissions have also addressed the issue of human cloning; all have drawn a distinct line between reproductive cloning and therapeutic cloning. The National Bioethics Advisory Commission determined that any attempt to clone human beings at this time would be immoral and contrary to public policy and recommended a moratorium on reproductive cloning, but remained silent on the issue of research cloning.[79] The National Academy of Sciences concluded

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the importation of any embryo or product derived from an embryo produced by human cloning, including stem cells or other medical treatments developed outside the U.S. H.R. 534 at §302(a), (b). The bill would punish any violation with $1 million minimum fines or as much as 10 years in prison. H.R. 534 at §302(c).

72. Human Cloning Prohibition Act of 2003, S. 245, 108th Cong. (as referred to S. Comm. on Health, Education, Labor and Pensions, Jan. 29, 2003).

73. However, Senate Bill 245 differs from House Resolution 534 in that it forbids the importation of embryos produced by human cloning but not the importation of any *product* derived from an embryo produced by human cloning, such as stem cells or other medical treatments. S. 245 at §498D(c). However, another provision of the bill appears to nullify this distinction by prohibiting shipping or receiving any products derived from human cloning outside the U.S. S. 245 at §498D(b)(3). Thus this bill presumably permits the importation of stem cells or other medical treatments produced from human cloning performed elsewhere only if it can be accomplished without any shipping or receiving, for example, by transport within a living human body.

74. Human Cloning Ban and Stem Cell Research Protection Act of 2003, S. 303, 108th Cong. (as referred to S. Comm. on the Judiciary, Feb. 5, 2003).

75. The Hatch Bill makes it unlawful to perform, attempt to perform, or participate in "human cloning," as narrowly defined, S. 303 at §301(b), and it punishes violations with the same civil and criminal penalties as House Resolution 534, plus forfeiture of any associated property, S. 303 at §301(d).

76. S. 303 at §301(a)(1).

77. S. 303 at §301(a)(6).

78. S. 303 at §499A.

79. Cloning Human Beings: Report and Recommendations of the National Bioethics Advisory Commission, vol. 1, June 1997, at 107-110.

that reproductive cloning should be prohibited, but research cloning should be permitted.[80] President George W. Bush's Council on Bioethics unanimously concluded that reproductive cloning should be prohibited, but divided on the issue of research cloning, with ten members supporting and seven members opposing a four-year moratorium.[81] And the California Advisory Committee on Human Cloning (of which one of the authors was a member) unanimously concluded in 2001, that the state should prohibit reproductive cloning but permit research cloning subject to reasonable regulations to ensure informed consent, require institutional review board approval, and limit research upon cloned human embryos to the first 14 days, prior to development of the primitive streak.[82]

Ironically, despite this emerging social consensus, there may be stronger constitutional arguments against a federal law banning reproductive cloning than there are against a law banning research or therapeutic cloning.[83] In terms of Congressional power, if "the Constitution requires a distinction between what is truly national and what is truly local,"[84] then Congress' power to regulate interstate commerce may not extend to reproductive cloning—an activity that may have little economic impact outside the boundaries of a particular state.[85] However, Congress probably does have the power to regulate research cloning because it is an activity that possesses real commercial significance. And in terms of constitutional rights, some scholars contend that the constitutional right to reproductive autonomy protects reproductive cloning.[86] However, the Supreme Court has held that there is little basis for a constitutional right to use life-saving medical treatments in the context of drug therapies not ap-

80. NAS Report, *supra* note 54, at 124.

81. Human Cloning and Human Dignity: An Ethical Inquiry, Report of the President's Council on Bioethics, July 2002 (*see* http://www.bioethics.gov/reports/cloningreport/pcbe_cloning_report.pdf).

82. Symposium, *Cloning Californians? Report of the California Advisory Committee on Human Cloning*, 53 Hastings L.J. 1143 (2002).

83. *See* Cass R. Sunstein, *Is There a Constitutional Right to Clone?*, 53 Hast. L.J. 987 (2001-2002).

84. *U.S. v. Morrison* (2000) 529 U.S. 598, 617 (finding unconstitutional a federal statute granting a civil remedy to victims of gender-motivated crimes).

85. *See* Ashutosh Bhagwat, *Cloning and Federalism*, 53 Hast. L.J. 1133 (2001-2002). *But see* Malinowski, *Choosing*, *supra* note 14, at 179-217 (2003) (arguing that assisted reproductive technology sector is a burgeoning business that markets itself aggressively across state lines and country borders and, therefore, should be subjected to federal regulation).

86. *See* John A. Robertson, *Liberty, Identity, and Human Cloning*, 76 Tex. L. Rev. 1371 (1998). *See generally* Lori B. Andrews, *Is There a Right to Clone? Constitutional Challenges to Bans on Human Cloning*, 11 Harv. J.L. & Tech. 643, 666 (1998); George J. Annas, *Human Cloning: A Choice or an Echo?*, 23 U. Dayton L. Rev. 247, 254 (1998); Andre P. Rose, *Note, Reproductive Misconception: Why Cloning Is Not Just Another Assisted Reproductive Technology*, 48 Duke L.J. 1133, 1150 (1999); Radhika Rao, *What's So Strange About Human Cloning?* 53 Hastings L.J 1007 (2002).

proved by the FDA, and an alleged constitutional right to conduct stem cell research probably falls into the same category.[87]

III. POPULATION GENETICS

Considerable ongoing biomedical R&D centers on population genetics and biobanking—the organized collection of DNA samples and medical histories, often from sizeable populations.[88] Demand for access to human biological samples and related medical information is at an all-time high, and rising.[89] This demand is driven by explosive bioinformatics capabilities that make it at least theoretically possible to work through the intricacies of the human genome; we now know that all human physiological and mental difference is attributable to just some 30,000 or fewer expressed genes.[90] With each increase in bioinformatics capabilities, the demand for access to human biological samples increases exponentially, and bioinformatics capabilities appear boundless at the present time.[91] Relative to the past, an extraordinary amount of information can be drawn from any given sample, and bioinformatics enables the processing of voluminous amounts of information from samples and medical records.[92] Together, bioinformatics capabilities and biobanks could prove the means to make medical sense out of the map of the human genome.[93]

Domestically, many biobanking initiatives are underway.[94] Vested U.S. biobankers include hospitals, universities, commercial

87. *U.S. v. Rutherford* (1979) 442 U.S. 544 (holding that there is no exception to FDA regulations for drugs for terminally ill patients).

88. *See generally Symposium: Regulation of Biobanks*, 33 J. L. MED. & ETHICS 1-188 (Mark Rothstein & Bartha Knoppers eds., 2005); POPULATIONS AND GENETICS: LEGAL AND SOCIO-ETHICAL PERSPECTIVES (Ed. Bartha Maria Knoppers, 2003).

89. *See generally* Michael J. Malinowski, *Taking Genomics to the BioBank: Access to Human Biological Samples and Medical Information,* 66 LA L. REV. 43, 52 (2006). *Cf.* Janet Woodcock, FDA *Policy on Pharmacogenomic Data in Drug Development*, 66 LA L. REV 91 (2006); Paula Yoon, *Risk Prediction for Common Diseases,* 66 LA L. REV. 33 (2006).

90. J. Michael McGinnis, *Population Health and the Influence of Medical and Scientific Advances*, 66 LA L. Rev. 9, 10 (2006).

91. Robert Wells, *Intellectual Property / Ownership Interests*, 66 LA L. Rev. 69, 70 (2006).

92. *See id.* at 71-72.

93. *See generally* A.E. Guttmacher, F.S. Collins, *Welcome to the Genomic Era*, 349 N. ENG. J. MED. 996-98 (2004), *available at* www.nejm.org; *Symposium: Regulation of Biobanks*, 33 J. L. MED. & ETHICS 1-188 (Mark Rothstein & Bartha Knoppers eds., 2005). *See also* L. Noah, *The Coming Pharmacogenomics Revolution: Tailoring Drugs to Fit Patients' Genetic Profiles*, 43 JURIMETRICS: THE JOURNAL OF LAW, SCIENCE, AND TECHNOLOGY 1, 4-11; (2002): Michael .J. Malinowski, *Law, Policy, and Market Implications of Genetic Profiling in Drug Development,* HOUSTON JOURNAL OF HEALTH LAW & POLICY 2 (2003): 31-63, 31-43.

94. *See* Michael J. Malinowski, *Technology Transfer in BioBanking: Credits, Debits, and Population Health Futures*, 33 J.L. MED. & ETHICS 54, 57 (2005).

entities, and even a state government.[95] For example, several major hospitals, including the Harvard-affiliated Beth Israel Deaconess Medical Center and Duke University Medical Center, are collaborating with Ardais Corporation to engage in biobanking.[96] Howard University is biobanking to advance research for diseases with distinguishably high incident rates among African-Americans, including hypertension and diabetes.[97] The State of Utah, in conjunction with the University of Utah and the Huntsman Cancer Foundation, has formed GenData, a non-profit corporation, to engage in biobanking that utilizes the rich legacy of medical record keeping associated with Utah's Mormon community.[98]

Globally, biobanking already has proven a means of entry to the genomics revolution for the populations of Iceland and Estonia.[99] Several other nations are undertaking biobanking endeavors.[100] Moreover, to explore the methodology of population genetics research based upon ancestry, the NIH, National Center for Human Genome Research Institute (NCHGRI), has undertaken the international HapMap Project (HMP).[101] This endeavor, a pilot program to explore scientific methodology, has raised a cluster of issues, including the scientific soundness of race-based research.[102] HMP is a collaboration among scientists and funding agencies from Japan, the United Kingdom, Canada, China, Nigeria, and the U.S.[103]

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95. *See generally* D.E. Winickoff, *Governing Population Genomics: Law, Bioethics, and Biopolitics in Three Case Studies*, 43 JURIMETRICS 187 (2003). *See also* Malinowski, *BioBanking*, *supra* note 94, at 57.

96. For more information, visit the site of Ardais at http:ww.ardais.com/national_initiative/index.html. *See* Malinowski, *BioBanking*, *supra* note 94, at 57; Winickoff, *supra* note 95, at 207.

97. A. Pollack, *Big DNA Files to Help Blacks Fight Diseases*, N.Y. TIMES, May 27, 2003, at A1, A20.

98. *See* BARRY R. FURROW ET AL., HEALTH CARE LAW 22-23 (West 2001, Supp. 2003).

99. *See generally* Mylene Deschenes and Clemintine Sallee, Accountability in Population Biobanking: Comparative Approaches, 33 J.L. MED & ETHICS 40 (2005).

100. Bartha Maria Knoppers, *Biobanking: International Norms*, 33 J.L. MED & ETHICS 7 (2005); Michael J. Malinowski, *Taking Genomics to the BioBank: Access to Human Biological Samples and Medical Information*, 66 LA L. REV. 43, 50 (2006).

101. Official sites with information about the HapMap Project are www.hapmap.org and www.genome.gov. *See generally* Ellen Wright Clayton, *Implications for Existing Law/Regulations*, 66 LA L. REV. 125, 126-27 (2006); Pilar Ossorio, *The Concept of Race in Social, Cultural and Political History, and the Potential Impact of Haplotype Mapping on the Future*, 66 LA L. REV. 131 (2006).

102. *See* Sharona Hoffman, *Is There a Place for "Race" as a Legal Concept?*, 36 AZ L. J. 1093, 1113-1128 (2004). *See also* David Rotman, Genes, Medicine, and the New Race Debate, TECH. REV., June 2003, at 41, 48, 50.

103. Homepage: http://www.hapmap.org/. The goal of HMP is to take the concept of familial-pedigree studies up to the population level—to compare the genetic sequences of different individuals to identify chromosomal regions where genetic variants are shared. HMP was commenced in October 2002, with Stage I planned for completion this fall (fall 2005). *See also* Ellen Wright Clayton, *Implications for Existing Law/Regulations*, 66 LA L. REV. 125,126 (2006); Pilar N.Ossorio, *The Concept of Race in Social, Cultural and Political History, and the Potential Impact of*

IV. ASSISTED REPRODUCTION TECHNOLOGY (ART) AND PREIMPLANTATION GENETIC DIAGNOSIS (PGD)

As recognized by the President's Council on Bioethics, "The awesome capability to intervene at the beginning of human life through medicine, to actually enable the creation of life and choices about human characteristics, has burgeoned in recent years and continues to expand at an ever-quickening pace."[104] In the U.S., this capability to intervene is realized largely through hundreds of private, self-regulated clinics that constitute a vibrant, growing economic sector generating many billions of dollars annually.[105]

Assisted Reproduction Technology (ART) is popular in the U.S., its popularity is growing, and ART is expanding parental choice—choice beyond whether to have children. Increasingly, ART is allowing parents to choose what genetic characteristics their children will or will not have.[106] Screening embryos for selection prior to implantation through preimplantation genetic diagnosis (PGD) could expand parental choice dramatically over the next several years.[107]

Haplotype Mapping on the Future, 66 LA L. REV. 131, 133 (2006) (Special Issue). The sample selection is deliberately based upon ancestry rather than any direct notions of race. Nevertheless, HMP has advanced with thoughtful attention to the implications of race-genetics connections. An ethics committee co-chaired by Dr. Bartha Knoppers and Dr. Ellen Wright Clayton has vested tremendous effort to address implications and develop algorithms for population genetics that potentially carry far beyond HMP. They also have made significant personal contributions to emphasize at conferences and in print that HMP is a pilot program to probe the scientific validity of ancestry-based population genetics. *See generally* Pilar N.Ossorio, *The Concept of Race in Social, Cultural and Political History, and the Potential Impact of Haplotype Mapping on the Future*, 66 LA L. REV. 131 (2006) (Special Issue). A fundamental outcome of this application of population genetics is pragmatic identification of ethical, legal, social and other policy implications of the research, and pragmatic methodologies and algorithms sensitive to those implications have been developed.

104. PRESIDENT'S COUNCIL ON BIOETHICS, REPRODUCTION AND RESPONSIBILITY: THE REGULATION OF NEW BIOTECHNOLOGIES (Mar. 2004), *available at* www.bioethics.gov.; Michael J. Malinowski, *A Law-Policy Proposal to Know Where Babies Come From During the Reproduction Revolution*, ___ IOWA J. GENDER L. POL'Y __ (forthcoming 2006). *See generally* ANALYTICAL SCIENCES, INC., CDC, FINAL REPORT SURVEY OF ASSISTED REPRODUCTIVE TECHNOLOGY: EMBRYO LABORATORY PROCEDURES AND PRACTICES (1999), *available at* http://www.phppo.cdc.gov/dls/pdf/art/ARTsurvey.pdf.; Erik Parens & Lori P. Knowles, *Reprogenetics and Public Policy: Reflections and Recommendations*, 33 HASTINGS CENTER REP. S1-S25 (2003) (special supplement); Malinowski, *Choosing*, *supra* note 14, at 172-197. *See also* PAUL CARRICK, MEDICAL ETHICS IN THE ANCIENT WORLD 99 (2001) ("[N]ever in human history has reproductive freedom been greater: we are now providing a single person or a couple the leeway to choose not only with whom, but when, and by what means conception will take place."). *Cf.* John A. Robertson, *Procreative Liberty in the Era of Genomics*, 29 AM. J.L. & MED. 439 (2003).

105. *See generally* Parens & Knowles, *Reprogenetics*, *supra* note 104. *See* Malinowski, *Choosing*, *supra* note 14, at 189-197.

106. *See generally* Parens & Knowles, *Reprogenetics*, *supra* note 104. *See* Malinowski, *Choosing*, *supra* note 14, at 189-197.

107. *See generally* John A. Robertson, *Debate, Extending Preimplantation Genetic Diagnosis: the Ethical Debate, Ethical Issues in New Uses of Preimplantation Genetic Diagnosis*, 3 HUMAN REPRODUCTION 18, 465-71 (2003).

"This reproduction revolution and the genomics revolution, both ongoing and raging, are crossing into each other through use of AR technologies."[108] The nexus between these revolutions has been termed "reprogenetics."[109]

The U.S. is readily distinguishable among industrialized nations in its delegation of ART services to the medical profession and private sector for self-regulation.[110] The Food and Drug Administration's jurisdiction historically has been checked to not interfere with physician discretion to practice medicine,[111] and AR is performed as a clinical service.[112] In fact, the Fertility Clinic Success Rate and Certification Act of 1992 (FCSRCA)[113] expressly provides, "In developing the certification program, the Secretary [of the Department of Health and Human Services] may not establish any regulation, standard, or requirement which has the effect of exercising supervision or control over the practice of medicine in an assisted reproductive technology program."[114]

Consequently, U.S. federal regulation consists almost entirely of self-regulation through a program of voluntary reporting and certification.[115] The federal system rests largely upon the FCSRCA, pursuant to which Center for Disease Control and Prevention (CDC) developed a model certification program for AR laboratories.[116] The

108. *See generally* Parens & Knowles, *Reprogenetics*, *supra* note 104. For discussion of the genomics revolution with a focus on several priority fields of study, *see Symposium Proceedings: The Genomics Revolution?: Science, Law, and Policy*, 66 LA. L. Rev. 1 (2006) (Special Issue) (live and published symposium sponsored in part by the Department of Energy-Human Genome Project Ethical, Legal and Social Implications Program).

109. Malinowski, *Reproduction Revolution*, *supra* note 104, at __ (forthcoming), *citing* LEE SILVER, REMAKING EDEN: CLONING AND BEYOND IN A BRAVE NEW WORLD (New York, Avon 1997); LORI ANDREWS, THE CLONE AGE: ADVENTURES IN THE NEW WORLD OF REPRODUCTIVE TECHNOLOGY (New York, Hering Holt, 1999); Parens & Knowles, *Reprogenetics*, *supra* note 104.

110. See Malinowski, *Choosing*, *supra* note 14, at 179-222.

111. *See* 21 U.S.C. § 396 (2000) (medical device regulation); 42 U.S.C. § 1395 (2000) ("Nothing in [Medicare] shall be construed to authorize any Federal officer or employee to exercise any supervision or control over the practice of medicine or the manner in which medical services are provided."); 37 Fed. Reg. 16,503, 16,504 (1972) ("[I]t is clear that Congress did not intend the [FDA] to regulate or interfere with the practice of medicine . . . .").

112. Malinowski, *Choosing*, *supra* note 14, at 180-189; Parens & Knowles, *Reprogenesis*, *supra* note 104, at S11-S12.

113. Fertility Certification Act, Pub.L. 102-493, 106 Stat. 3146 (1992), 42 U.S.C. 263a-1 et seq.

114. 42 U.S.C. § 263a-2(i)(1) (2000).

115. *See* Lars Noah, *Assisted Reproductive Technologies and the Pitfalls of Unregulated Biomedical Innovation*, 55 FLA. L. REV. 603, 614-616 (2003); Malinowski, Eugenics, *supra* note 1, at 180-197. *But see* Parens & Knowles, *Reprogenetics*, *supra* note 104, at S12 (stating that the FCSRCA does require clinics offering AR services to disclose pregnancy success rates to CDC).

116. The model program is *available at* http://www.cdc.gov/reproductivehealth/ART/index.htm. Supplemental sources of regulation include state regulation, practice standards set by professional organizations, and FDA's assertion of jurisdiction over

states have not adopted that program. CDC has contractually outsourced implementation of its responsibilities under the FCSRCA to the Society for Assisted Reproductive Technology (SART) and the American Society for Reproductive Medicine (ASRM).[117] SART-ASRM collects, processes, and reports the data submitted voluntarily from members to CDC, which in turn processes that data in a standard format and issues reports annually for public dissemination.[118] However, in addition to the CDC's implementation of FCSRCA, the Federal Trade Commission (FTC) has jurisdiction to police marketing claims and has used that authority to investigate some AR providers.[119] Some states have done the same.[120]

V. THE IMPACT OF FDA CONTROVERSIES ON BIOTECHNOLOGY

The FDA presently is going through a difficult time. The ongoing Cox-2 controversy and other recent events, such as the alleged failure of Lilly to disclose troubling clinical data for Prozac even though it has been on the market for years,[121] have, at the very least, caused many to seriously question whether the reforms to modernize the agency during the 1990s simply went too far.[122] Biotechnology was a major beneficiary of these reforms, the mantra of which was to increase responsiveness to and accelerate the review and development of innovative biopharmaceuticals.[123] Meaningful regulatory re-

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human cloning and ooplasm transplantation. Parens & Knowles, *Reprogenetics, supra* note 104, at S12.

117. For information about these organizations, visit www.sart.org and www.asrm.org.

118. *See, e.g.,* CDC, Report, *supra* note 1. These reports are issued annually, but presently are running two years behind the governing calendar year. *See generally id.*

119. Noah, *Pitfalls, supra* note 115, at 615 & n.49.

120. *See id.* at 615-616 (acknowledging that some states have enacted legislation, and there is at least some precedent for AR patients to seek redress under general consumer protection laws). Several commentators have called for increased consumer protection in the field of AR. *See, e.g.,* Lori B. Andrews & Nanette Elster, *Regulating Reproductive Technologies*, 21 J. LEGAL MED. 35, 50 (2000).

121. Ken Belson, *Lilly Shares Fall on Report About Prozac Documents*, N.Y. TIMES, Jan. 1, 2005, at C2; Alex Bernson, *An Industry in Poor Health*, N.Y. TIMES, Dec. 18, 2004, at A1; Barnaby J. Feder, *The Fallout from Celebrex*, N.Y. TIMES, Dec. 18, 2004, at B1; Gina Kolata, *A Widely Used Arthritis Drug is* Withdrawn, N.Y. TIMES, Oct. 1, 2004, at A1; Barry Meier, *A Top Republican to Offer Drug Data Bill*, N.Y. TIMES, Dec. 10, 2004, at C3; Anahad O'Connor & Denise Grady, *Problems May Send Many Patients Back to Good Old Aspirin*, N.Y. TIMES, Dec. 18, 2004, at B1. Several major pharmaceutical companies, in an effort to preempt government mandates, are now posting much more clinical data voluntarily. Meier, *supra*.

122. This modernization refers to implementation of the Food and Drug Administration Modernization Act of 1997. Pub. L. No. 105-115, 111 Stat. 2296 (codified throughout 21 U.S.C.) [hereinafter "FDAMA"]. For criticism of the present regulatory scheme and assertions of excessive drug company influence over the FDA, *see generally* MARCIA ANGELL, THE TRUTH ABOUT DRUG COMPANIES: HOW THEY DECEIVE US AND WHAT TO DO ABOUT IT (Random House, 2005).

123. *See* Michael J. Malinowski, *FDA Regulation of Biotechnology Products for Human Use, in* ENCYCLOPEDIA OF ETHICAL, LEGAL AND POLICY ISSUES IN BIOTECHNOL-

form—more government regulation, self-regulation (such as voluntary disclosure of clinical data now being undertaken by some pharmaceutical companies), or some combination of the two—may be necessary to restore the public's faith in and reliability of the Agency:[124]

> [User fees] have greatly expanded the FDA's resources, and also created much more dialogue among the FDA, industry, and academia.[125] Ultimately, you end up in a world where a very thick and long-standing wall was taken down between industry and the government through regulatory reform. While razing this wall arguably was necessary to fuel the genomics revolution,[126] accountability mechanisms must be added in its place to ensure some regulatory checkpoints.[127]

Nevertheless, the FDA has demonstrated resourcefulness and dynamism in responding to "new science" that has inundated the Agency in recent years, and it appears that it is continuing to do so.[128] For example, the Agency is responding to the challenge of transitioning into pharmacogenomics and pharmacogenetics with thoughtfulness and initiative.[129]

VI. The Nexus Between the U.S. Health Care Finance Dilemma and Commercial Biotechnology

According to a study conducted to quantify the rate of return on publicly-funded research published by the U.S. Congressional Joint

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OGY 221 (Thomas J. Murray & Maxwell J. Mehlman eds., 2000, John Wiley & Sons, Inc.) (quoting the relevant provisions of FDAMA).

124. Malinowski, *Future Stem Cell Human Health Applications*, *supra* note 65, at 658-659.

125. Prescription Drug User Fee Act of 1992, Pub. L. No. 102-571, 106 Stat. 4491 (codified throughout 21 U.S.C.) [hereinafter PDUFA I]. PDUFA I was reauthorized (PDUFA II) in the context of FDAMA. *See* Prescription Drug User Fee Act of 1994, Pub. L. No. 102-571, 106 Stat. 4491 (codified in scattered sections of 21 U.S.C. 301 et seq.), renewed as an addendum to FDAMA. FDAMA renewed the use fee program for five years and introduced new performance goals and other fundamental adjustments. *See* User Fee Amendments of 2002, Pub. L. No. 107-188, 116 Stat. 687 (codified throughout 21 U.S.C.) [hereinafter PDUFA III] (extending the program to Sept. 30, 2007). *See generally* Food & Drug Admin., *PUDFA III Five-Year Plan*, *available at* http://www.fda.gov/cc/pdufa3/2003plan/default.html (July 2003).

126. For support of federal technology transfer policy and practice, *see generally* Nat'l Insts. of Health, *NIH Response to the Conference Report Request for a Plan to Ensure Taxpayers' Interests are Protected*, *available at* http://www.nih.gov/news/070101wyden.htm (July 2001); GAO Report, *supra* note 4.

127. *See generally* Symposium, *Conflicts of Interest in Clinical Research: Legal and Ethical Issues*, 8 Widener L. Symp. J. 47, 47-73 (2001).

128. *See generally*, Woodcock, *FDA Policy*, *supra* note 89, at 94 (2005). *See also* Malinowski, *Future Stem Cell Applications*, *supra* note 65, at 659 (addressing the tissue track).

129. For an inside-the-FDA account of exactly what the agency is doing to advance this transition, *see generally* Woodcock, *FDA Policy*, *supra* note 89.

Economic Committee (JEC) in May 2000, the benefit from increased life expectancy in the U.S. attributable to advances in health care generates annual net gains of approximately $2.4 trillion (using 1992 dollars).[130] The JEC concluded, "If only ten percent of those increases in value ($240 billion) are the result of NIH funded medical research, it indicates a payoff of about 15 times the taxpayers' annual NIH investment of $16 billion."[131] Similarly, the General Accounting Office and NIH each have issued reports that indicate taxpayers receive a multiple return on every dollar invested in biomedical research and development.[132] And the U.S. has drawn an increased share of global pharmaceutical investment in R&D. According to industry, "U.S. public policies and support for R&D have created a major shift in dominance from Europe to the U.S.—a shift that has included the relocation of many European pharmaceutical companies and researchers to America."[133]

Nevertheless, biopharmaceuticals are entering a U.S. health care finance system that is infamous and worsening: 45 million people are uninsured, most of them working, and many millions more are underinsured;[134] costs are rising significantly and shifting from employers to employees;[135] a $62 trillion shortfall is projected for Medicare, due largely to the new prescription drug benefit;[136] states are slashing programs to offset their shortfalls, and the Bush Administration is granting Medicare program waivers almost carte blanche to accommodate the same; and the Administration has proposed cutting $60 billion (two percent) from Medicaid over the next decade.[137] The situation is disparately worse for minority groups. Both the Institutes of

130. *See generally* JEC, *The Benefits of Medical Research*, *supra* note 4.

131. *Id.*

132. *See generally* GAO REPORT, *supra* note 4; NIH, TAXPAYERS' INTERESTS, *supra* note 4; NIH, TECHNOLOGIES, *supra* note 4.

133. PhRMA, PROFILE, *supra* note 1, at 20.

134. Shannon S. Venable, *A Call to Action: Georgia Must Adopt New Standard of Care, Licensure, Reimbursement and Privacy Laws for Telemedicine*, 54 EMORY L.J. 1183, 1183-1184 (2005).

135. Anne D'Innocenizo, *Health Care Costs Continue to Shift*, CHARLOTTE OBSERVER (NC), Sept. 14, 2004, at 3D, *available at* 2005 WLNR 14458548; Glen Singer, *Survey Shows Employers Will Shift Burden of Health Benefits Increase*, SUN-SENTINEL, Aug. 27, 2004, *available at* 2004 WLNR 14532557; Anne D'Innocenizo, *Employers Shift Health Costs-Workers Will Take Larger Share in 2006*, COM APPEAL, Sept. 14, 2005, at A3; *Study Shows Impact of 6 Years of Double-Digit Medical Rate Increases*, MANAGED CARE WEEKLY DIGEST 103, Mar. 28, 2005, *available at* 2005 WLNR 4654487.

136. Alan Fram, *Deficit Could Hit Record $477B*, CINCINNATI POST, Jan. 26, 2004, at A2; Robert Pear and Edmund L. Andrews, *White House Says Congressional Estimate of New Medicare was Too Low*, N.Y. TIMES, Feb. 2, 2004, at A14; *Staggering Hidden Costs of Medicare Prescriptions*, New American, Feb. 23, 2004, at 9; *The Medicare Alarm*, ALBANY TIMES UNION, Apr. 5, 2004, at A6.

137. Josh Goldstein, *U.S. Medicaid Cutbacks Would Hurt States Twice*, PHILADELPHIA INQUIRER, Feb. 8, 2005, at C1; *How Bush's Budget Goes Wrong*, BUS. WEEK, Feb. 28, 2005, at 112; Robert Pear, *Governors Prepare to Fight Medicaid Cuts*, N.Y. TIMES, Feb. 27, 2005, at 127.

Medicine (IOM)[138] and the Agency for Healthcare Research and Quality (AHRQ) at the Department of Health and Human Services (DHHS) have documented that minority groups in the U.S. have significantly less access to health care, and the care they receive is of much lower quality.[139]

While the public is demanding access to pharmaceuticals at lower costs, biopharmaceuticals are almost certain to increase those costs substantially, thereby challenging the already troubled U.S. health care finance system.[140] Genetic precision is likely to fracture traditional disease groups, resulting in fewer patients to share the R&D costs of developing new biopharmaceuticals, and those costs are rising.[141] Moreover, some economists are calling into question the cost-effectiveness of individualizing medicine, including extensive use of genetic profiling.[142] Clinician acceptance and accurate use of gene-based diagnostics and therapies poses another significant challenge.[143] Presumably, biopharmaceuticals and gene-based therapies will reduce costs when they offer cures rather than just treatments, but that is not a present reality and may not be realized for many years.[144]

VII. CONCLUSION

The overarching theme of this report is that the U.S. public, government, and private sectors have demonstrated commitment to biotechnology R&D and its applications. This commitment, evident in early completion of the HGP,[145] has blossomed into a bouquet of undertakings such as the HapMap Project,[146] the SNPs Consortium, and heavy utilization of biotech in biopharmaceutical R&D.[147] And it is resulting in at least the beginning of an actual impact on the delivery of health care, most notably through the market introduction of biopharmaceuticals and widespread genetic profiling—in drug devel-

138. *See generally* Institutes of Medicine, http://www.iom.edu.

139. *See generally* Agency for Healthcare Research and Quality, http://www.ahrq.gov.

140. *See* McGinnis, *supra* note 90, at 9. The level of precision introduced by biopharmaceuticals will result in smaller patient groups shouldering drug R&D costs, and this trend is likely to continue until technology evolves to actually eliminate diseases rather than turning them into chronically treated conditions. *See* id. at 20.

141. *See id.* at 19.

142. *See generally* Jeffrey L. Moe, *Commercialization Considerations (Perspectives of Drug Manufacturers, Patients, Reimbursers, Regulators and Health Care Providers) for Individualized Diagnostic and Drug Therapies Resulting from Pharmaceogenomics*, 66 LA L. REV. 103, 104, 105 (2006) (Special Issue).

143. *Id.* at 106.

144. *See generally* Woodcock, *FDA Policy*, *supra* note 89, at 101, 102 (2006) (Special Issue).

145. *See supra* note 3 and accompanying text.

146. *See supra* notes 13, 101 and accompanying text.

147. *See supra* notes 6-7 and accompanying text.

opment, human reproduction, and general health care.[148] Applied biotechnology now is integrating with health care, and thereby becoming entangled with, and in some instances exacerbating, the controversies associated with the U.S. health care finance system.[149] Given its deep commitment, the impact of biotechnology on the U.S., both economically and in terms of delivery of health care, will become significantly greater over the next several years and well into the foreseeable future.

148. *See supra* notes 7, 134, 143 and accompanying text.

149. *See supra* notes 134-144 and accompanying text. *See also* Moe, *Commercialization Considerations*, *supra* note 142, at 115.